Why Does a Ball Curve?

Part 2 - John Pinkman

In our last episode (CB 3/1/02) we heard tell of 120 high school pitchers in our program, most of whom were puzzled at the concept of a 2-seam fastball. That story reminded me of a TV commercial a few years ago. I actually forget the product, but the scene is a father and son at a baseball game. The son says, "Daddy, why does a curveball curve?" While demonstrating a simulated ball path with a wave of his hand, the father begins to answer with the voice of authority, "You see, son, it goes this way and spins and uh…." All of a sudden it dawns on him he has no idea of what he thought he knew for certain. Worse, he couldn't explain or teach the concept. It struck home because I'm sure all of us have been there before. Great coaches recognize that feeling and change it, by learning.

Over my career I have taught almost 1000 pitchers. And I have heard a lot of stories overtime. The stories that have most affected and motivated my study of teaching are when players talk about training attempts of previous coaches. I get those stories because they feel safe telling me. I can't cut them, unlike their school coach. But the bottom line is - in this era of baseball, like the TV commercial - you can't smoke screen a lack of knowledge. **Particularly with pitchers.**

We teach the aerodynamics of ball flight **before** we teach the grip. Recently we asked students to draw, in detail, a ball from 3 different angles to learn ball geography. How many kids in your program know that with every ¼ turn of a ball, the seams turn completely opposite?

The basics of flight are really enough. We instill this simple but alternative view from what they think they know. A pitcher doesn't throw a curve ball. He creates an aerodynamic incident that occurs 45' away. And in order to do that, he must consistently control the axis of ball rotation.

If you tell a pitcher to "just grip it this way and throw", they may forget or unintentionally adjust the grip. Consequently, when the ball flight fails to fly as expected they cannot make the correlation of why it failed and take corrective action. They have no actual knowledge of what they just did. This also applies to outfielders as well; the longer the distance the greater the error in movement.

But the first solution pitchers almost always try is increasing the spin on the ball by improperly and dangerously twisting muscle groups. That simply results in sore arms. The amount of spin is important, but it is not **as** important as most think. The axis of rotation and ball velocity produces predictable and consistent ball movement. Let the ball do the work!

There are four basic physical science factors in baseball flight: two uncontrollable constants - distance and gravity, and two controllable variables - velocity and axis of rotation. Additional weight from a wet ball, game temperature, and wind are somewhat variable factors, but I believe these affect release point and a

personal confidence in executing the pitch more than they affect ball flight. The height or thickness of the seams is a factor as well. Raised seam balls track straighter and create more directional movement than lower profile seams. However they have reduced velocity.

We produce graphs to aid in learning. They work!

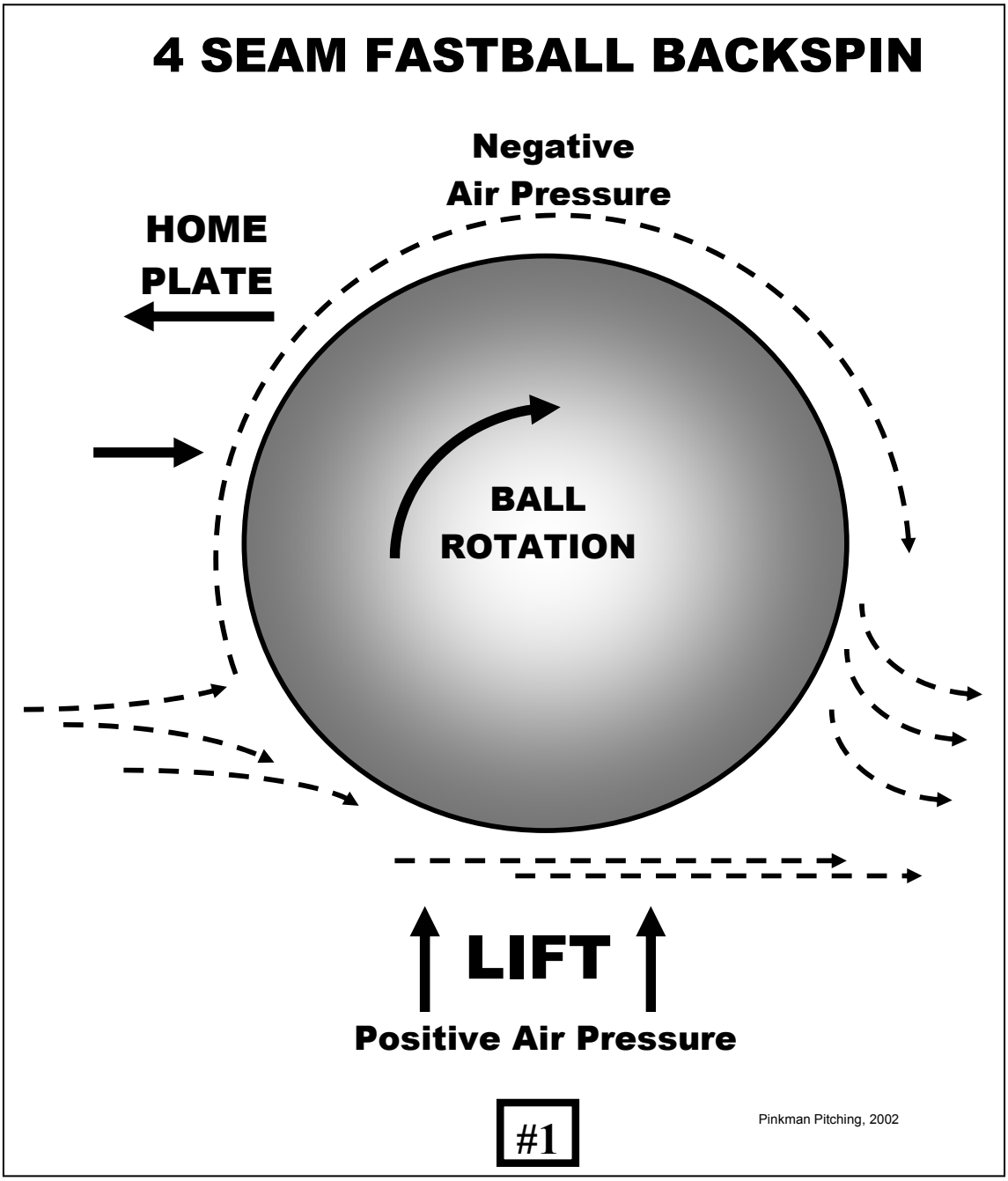
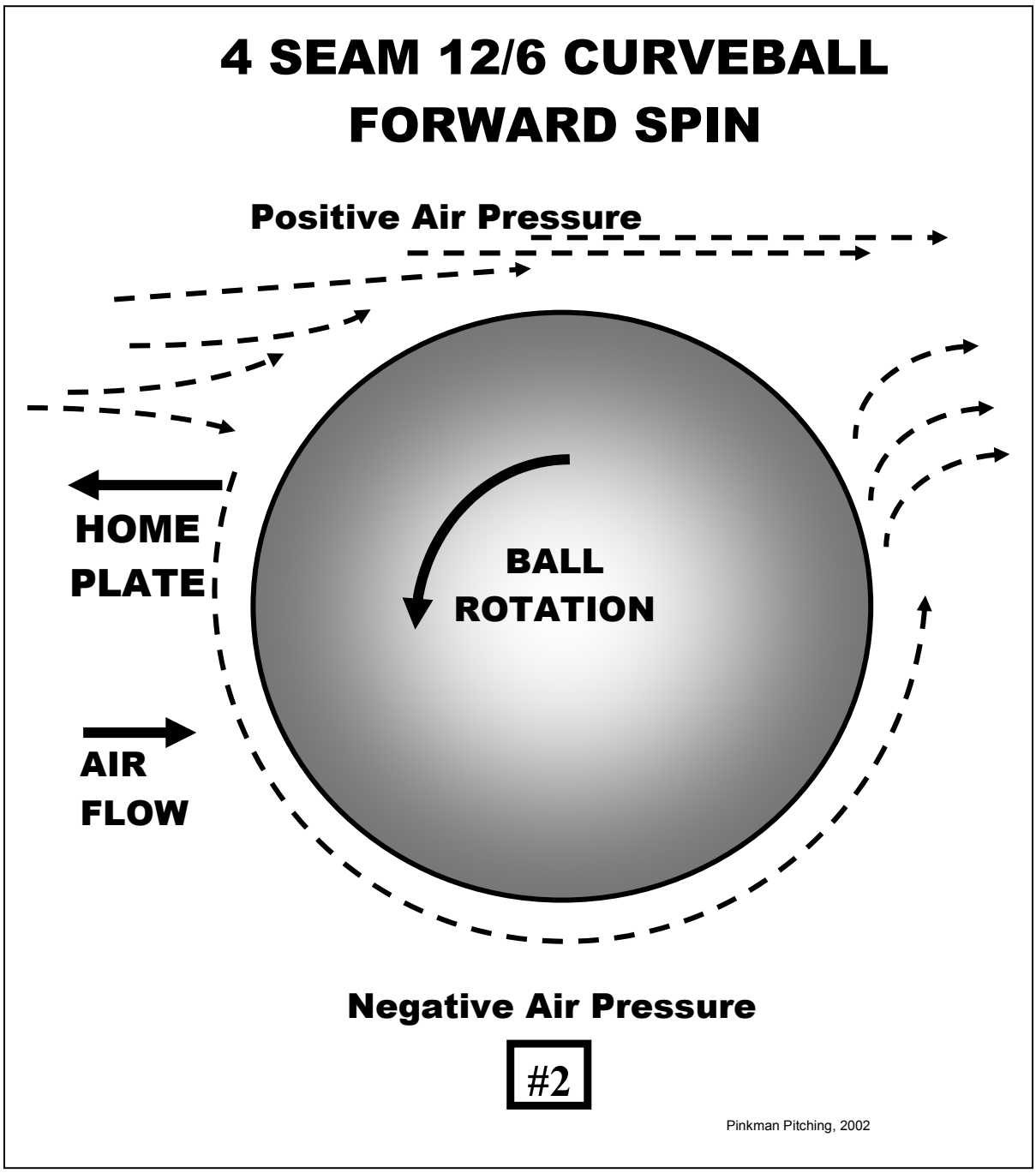
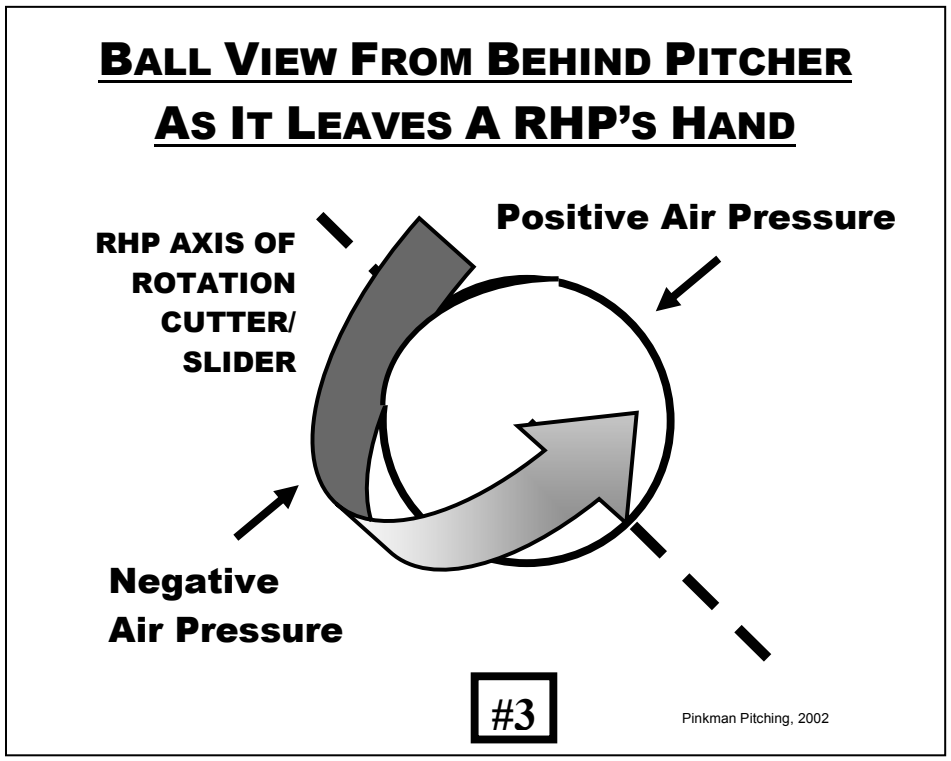


Figure 1 describes the aerodynamics of airplane flight. The airflow moving over a shorter distance on the bottom increases air pressure, or lift, under the ball. Conversely, the airflow moving over the top of the ball decreases air pressure on the top.



However, unlike an airplane wing, the direction of spin rotation of a ball affects the pressure dynamic. As seen in **Figure 2**, reversing the spin rotation also reverses the air pressures.

Figure 3 represents a cutter or slider for a RHP. Figure 4 represents the same for a LHP. By releasing the ball with a slightly forward spin and a clockwise motion (or counter clockwise for LHP) the air pressure pushes on the ball in the appropriate direction.



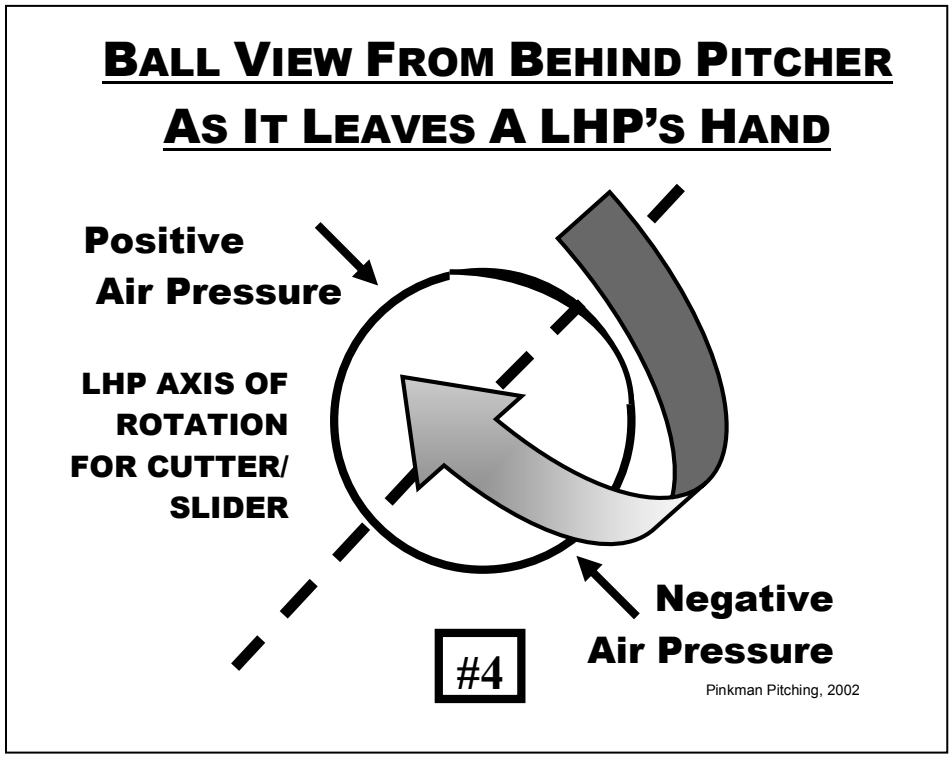


Figure 5 shows that a true curveball and a 4-seam fastball share the same axis. The curveball's forward rotation will drop relative to distance and velocity. The fastball resists dropping. Scientists indicate humans cannot create enough velocity of backspin to make the ball rise as it passes the plate.

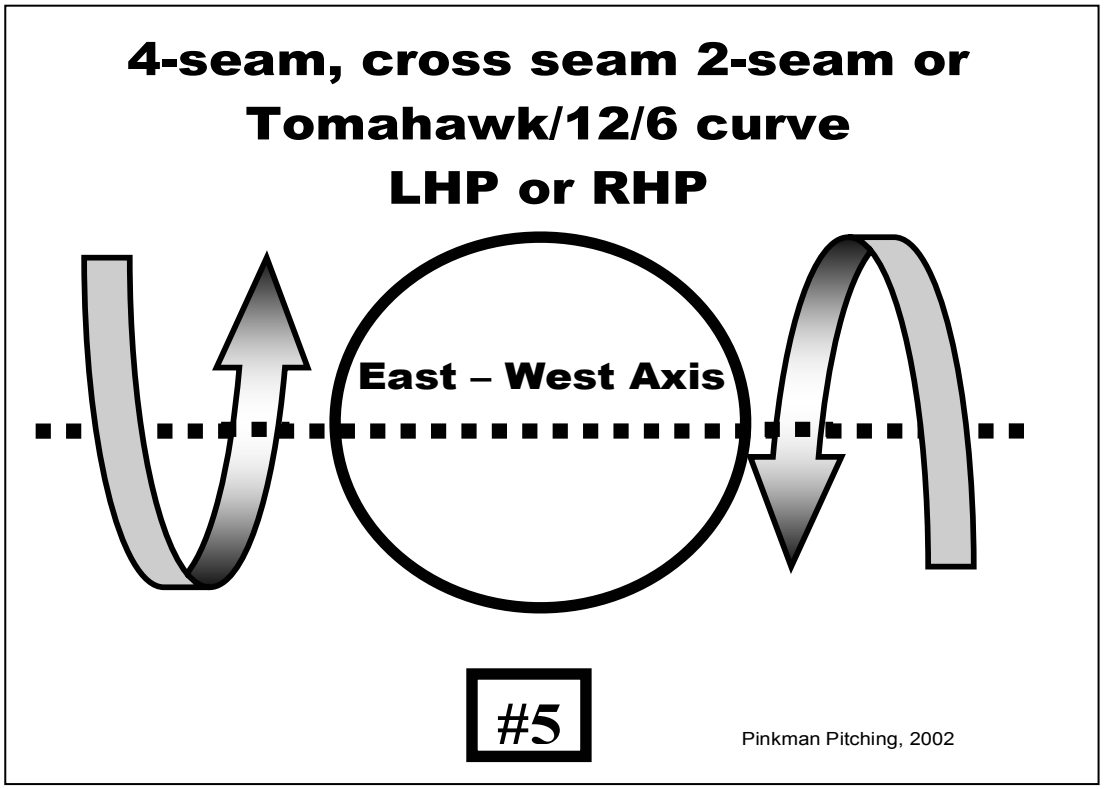
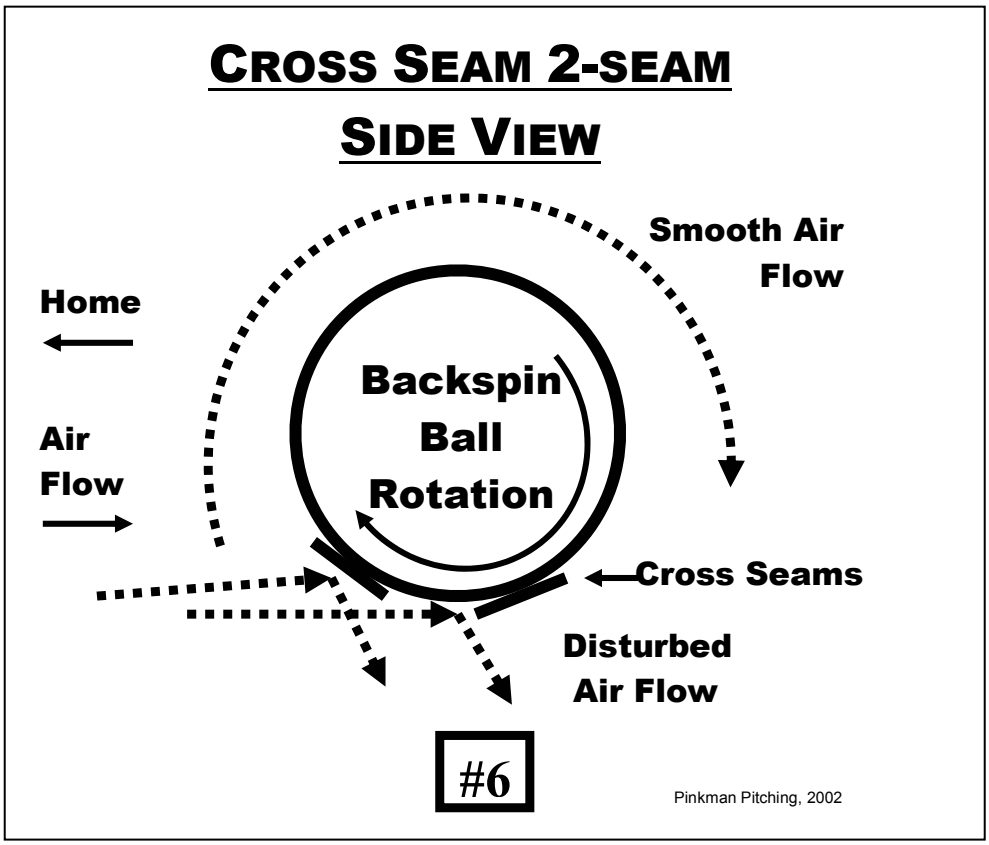


Figure 6 (next page) identifies the airflow on a sinking 2-seamer. Placing the fingers parallel and on top of the 2 long seams creates less air disturbance and less ball drop. The biggest need here is to understand that on a sinking 2-seamer the 2 short cross seams (one set lies directly above and one directly below the ball label) create all airflow disturbances on ball movement. Placing fingers across and perpendicular to the 2 short seams immediately generates more backspin force as the ball leaves the hand and the 2 cross seams hit the airflow. TRY IT! (Part Three will include photos of this, offset 2-seamers & cutters and a sure fire image to predict a sore arm in the near future.)

Once the ball leaves the hand, the axis of rotation remains the same until the ball is hit, hits the dirt, or is caught. As the ball approaches home, directional pressures increase. The distance to the plate or air friction allows gravity to overtake speed. A baseball loses 1 MPH for every 7 feet traveled. The combination of these factors produces directionally controlled movement. However, the ball flight becomes predictable only when the desired axis of rotation is created at a similar release point with consistent velocity.



Problems with the amount and consistency of movement always occur. Pitchers' incorrect conventional wisdom tells them to make the ball spin faster to make the ball curve more. Incorrectly placing too much spin slows the ball down and what appears to be more movement is just a gravity ball. Pitchers intuitively know that the number of times the ball can rotate between the release and home plate is also relative to release point and speed. Therefore they release the ball earlier, behind the head, it takes an upward arch to accommodate the distance needed to reach the plate - the definition of a hanging curve.

It is true that applying more spin with the correct axis of rotation will cause the ball to move more. But in so many cases applying too much spin with the correct axis will create too much movement and the ball will not reach the plate.

You can learn this. You can teach this. It takes some off-field time. The big benefit will result in both you and your pitchers knowing why the pitch is working so you can count on its consistency or….. Fix it.

And don't forget that one day "your" son may ask you, "Daddy… what make a curveball curve?" Hopefully, the 'birds and the bees' questions will be harder to answer.

(Part 3 in this series will detail ball grip and teaching methods that consistently work for pitchers.)

Reference: Adair, Robert, *The Physics Of Baseball*, Professor of Physics, Yale University. Contributors to this article: Ken Uffelman, Aerodynamic Engineer, TRW Inc.; Bill Moorehead, MA, Harvard University.